

The background of the slide is a piece of marbled paper with a complex, organic pattern of swirling lines in shades of beige, cream, and light brown.

# **New Mexico Tech/METTOP Lead Free Solder Project**

Aging Aircraft 2008

# **METTOP Lead-Free Solder Research Team**

- Stephen Bracht, Electrical Engineer
- Lisa Salerno, Material's Engineer
- Aghavni Ball, Electrical Engineer

# History Overview

- METTOP- Micro Electronics Testing and Technology Obsolescence Program
  - Began studying lead-free solder in 2007



# METTOP



# LEAD-Free Group

- NMT Collaborations
  - NSWC Crane/Purdue/SAIC: Project 1722
  - NMT emphasis on solder joint reliability, particularly vibration

# LEAP-WG

- NMT involved since September 2007
- LEAP-WG includes members from all stakeholders
- Addresses lead-free issues that are unique to aerospace and military, and within control of aerospace and military



# NMT Vibration Testing

- Follow-on project to JCAA/JGPP vibration test
- Vibrating salt fog PCB boards from JCAA/JGPP project
- Added stiffeners and more accelerometers

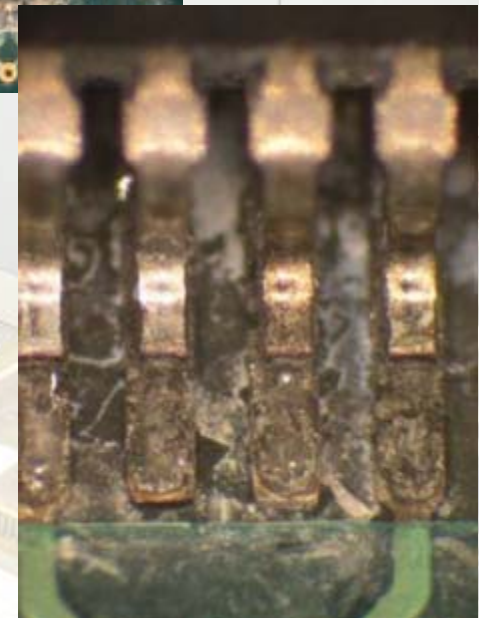
# Salt Fog Boards



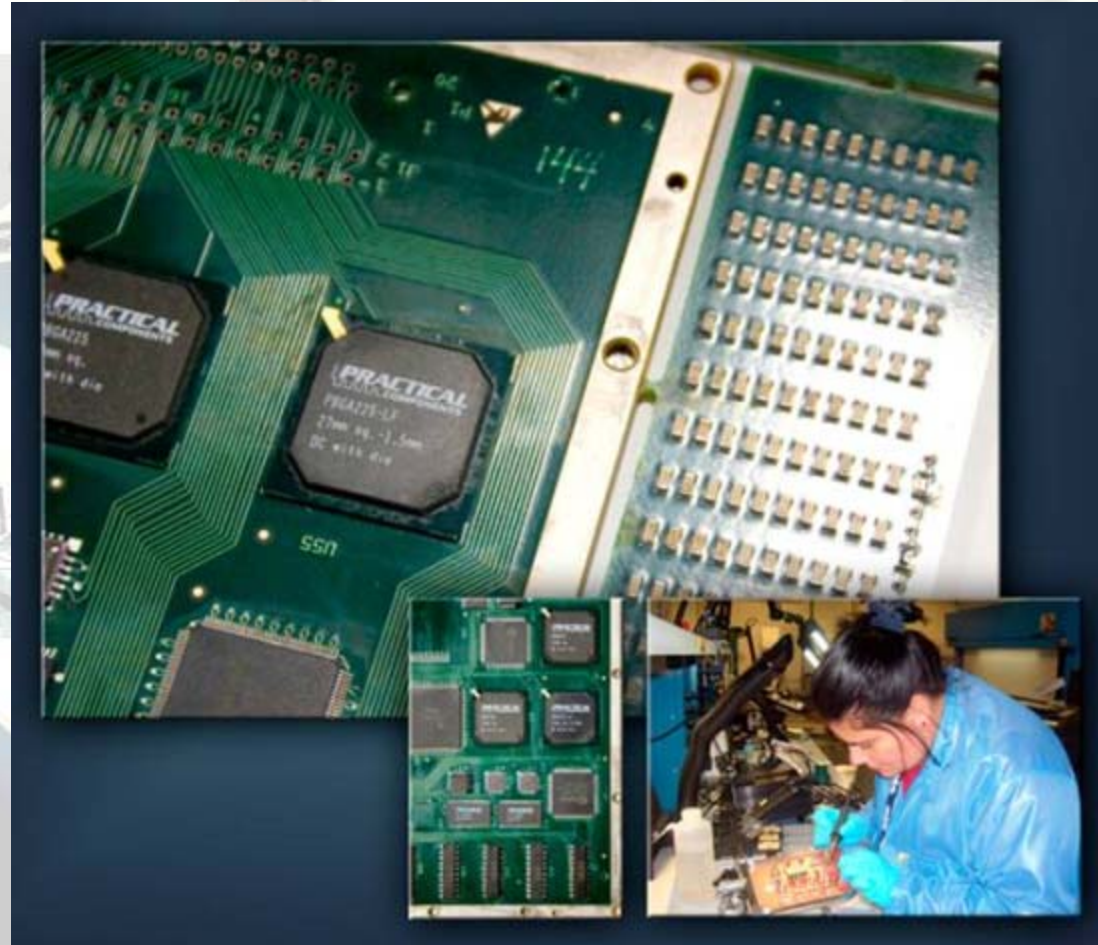


# Salt Fog Boards

- Corrosion between leads
- Lifting of leads
- Issue seems limited to TQFP-208s



# Damage Assessment





# Failed Components

- Nineteen parts had failed before vibration took place
- Three of these were bad before the salt-fog study
- The remaining sixteen failed due to corrosion from salt fog residue



# Test Plan

- Stiffen the nine boards given to us from JGPP 1 study
- Vibrate based on the original Woodrow study at Boeing
- Evaluate
  - See reduction in deflection
  - Effects on solder joint reliability

# Modal Analysis

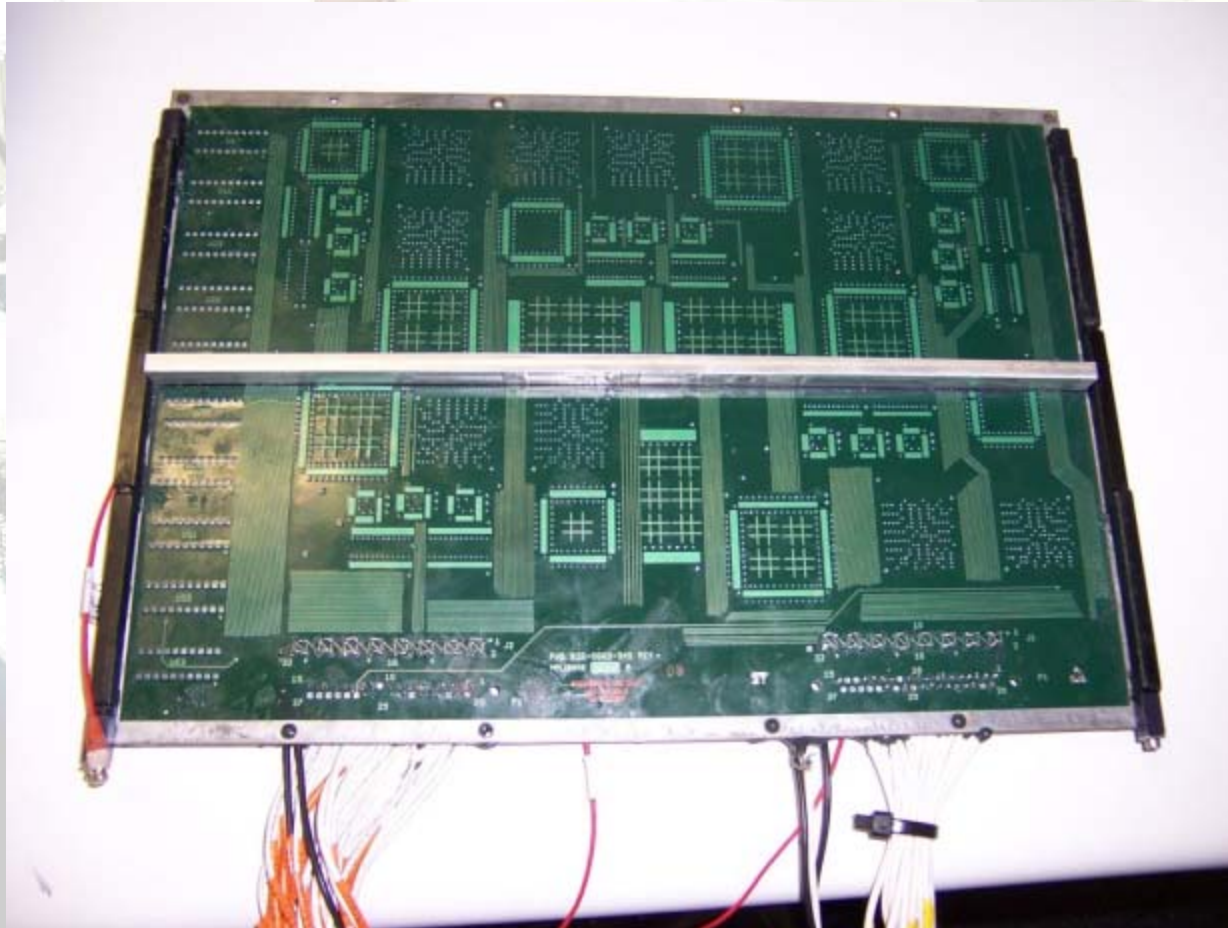
- CirVibe Software
  - For pre-test modal analysis
  - To determine stiffener and accelerometer placement

# Types of Stiffeners

- Stiffeners- used to suppress resonance at a particular forcing frequency
- Used CirVibe to determine stiffener placement
- Adhered using adhesive



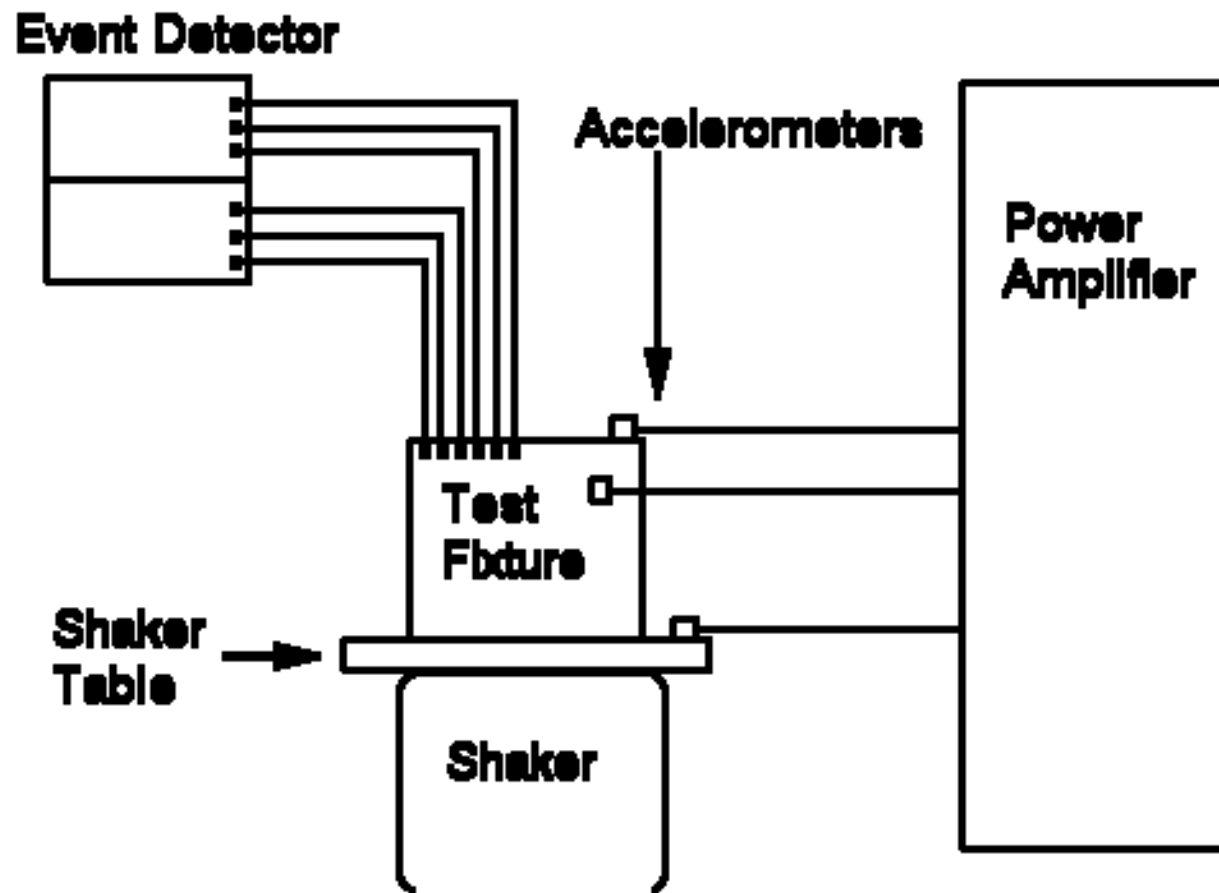
# Stiffener Placement



# Accelerometer Placement

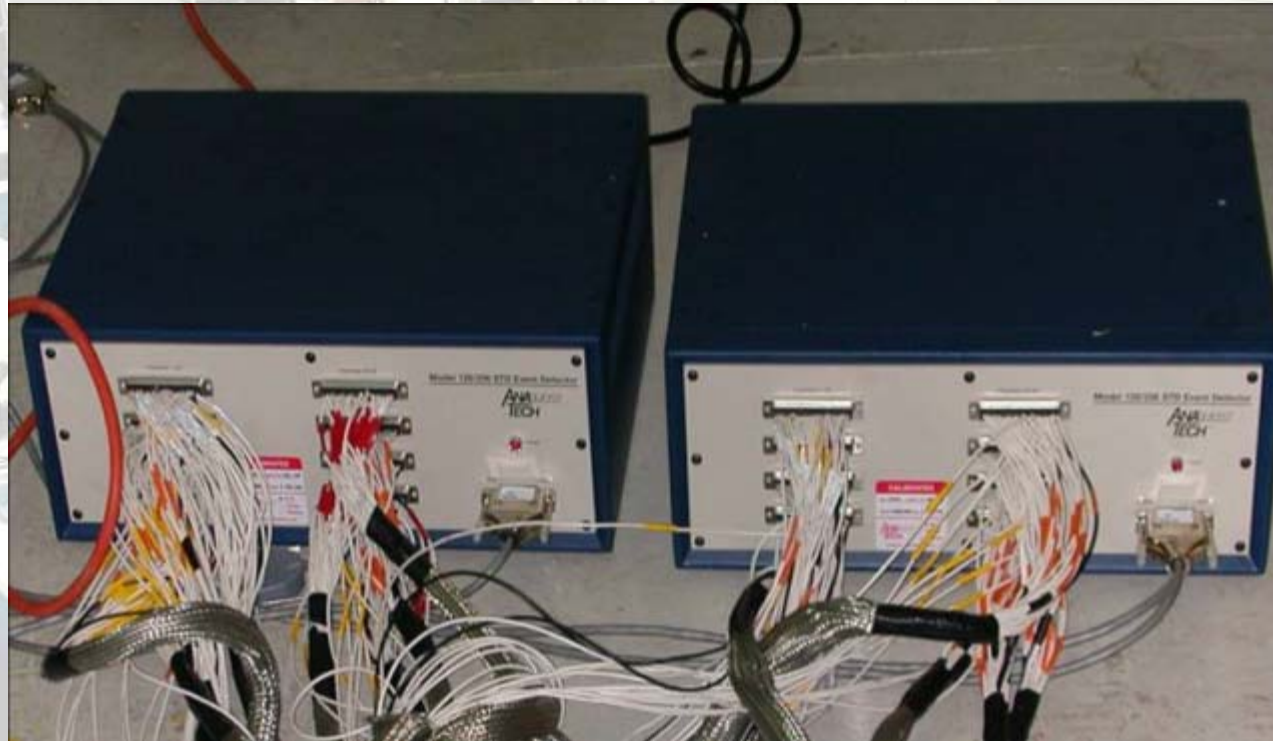


# Test set up





# Event Detectors

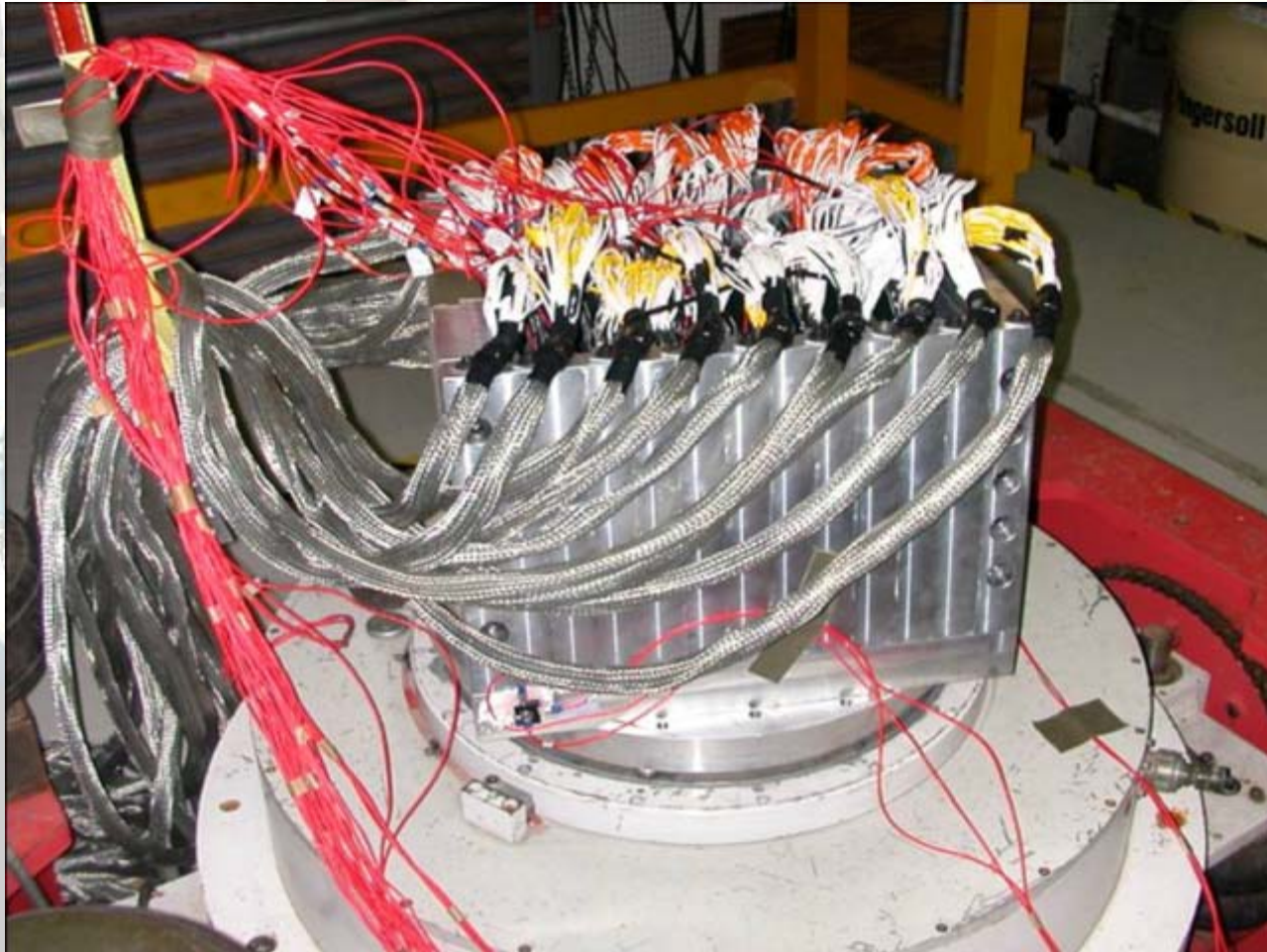


# Y-Axis setup



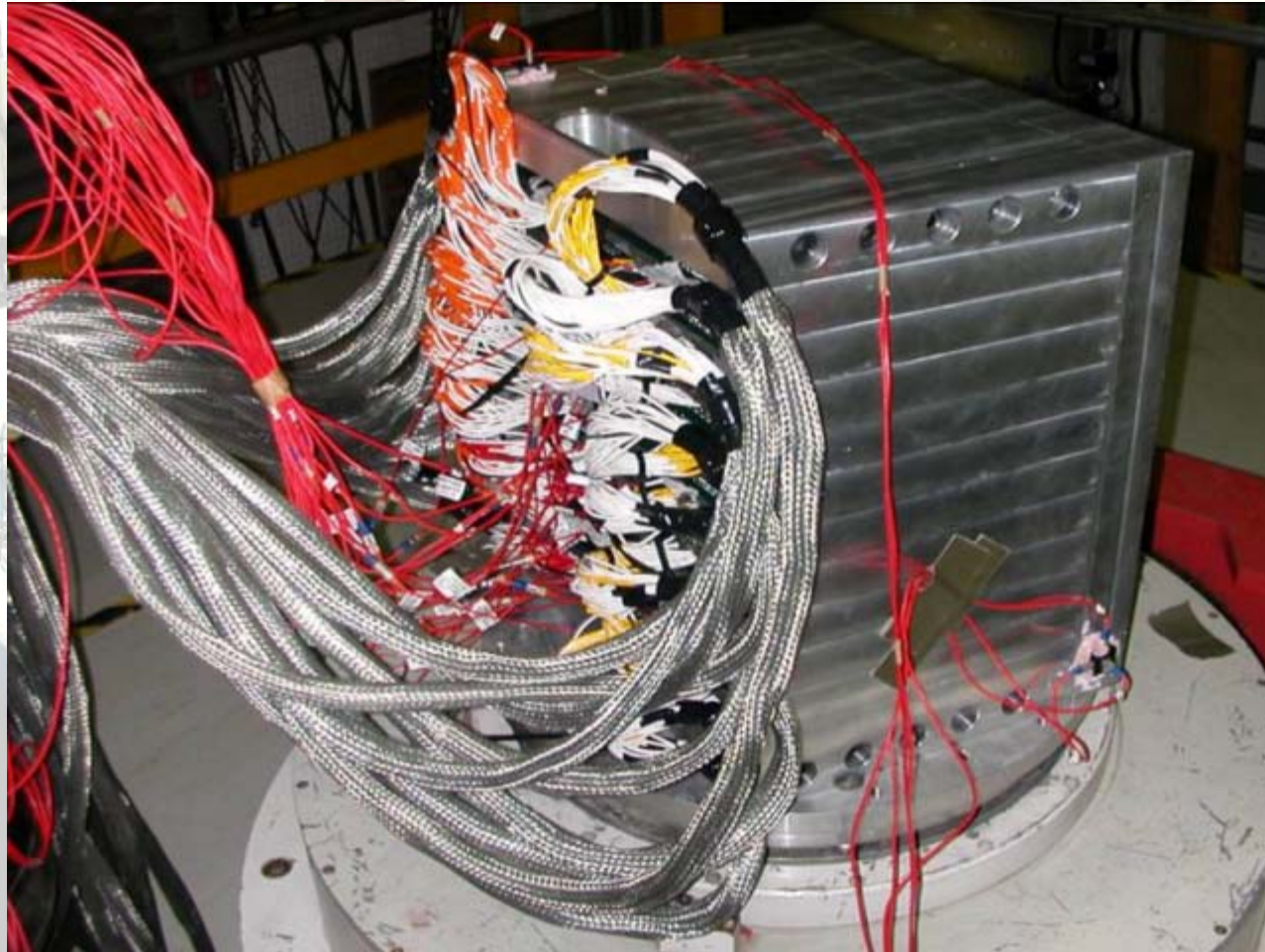


# **X-Axis setup**

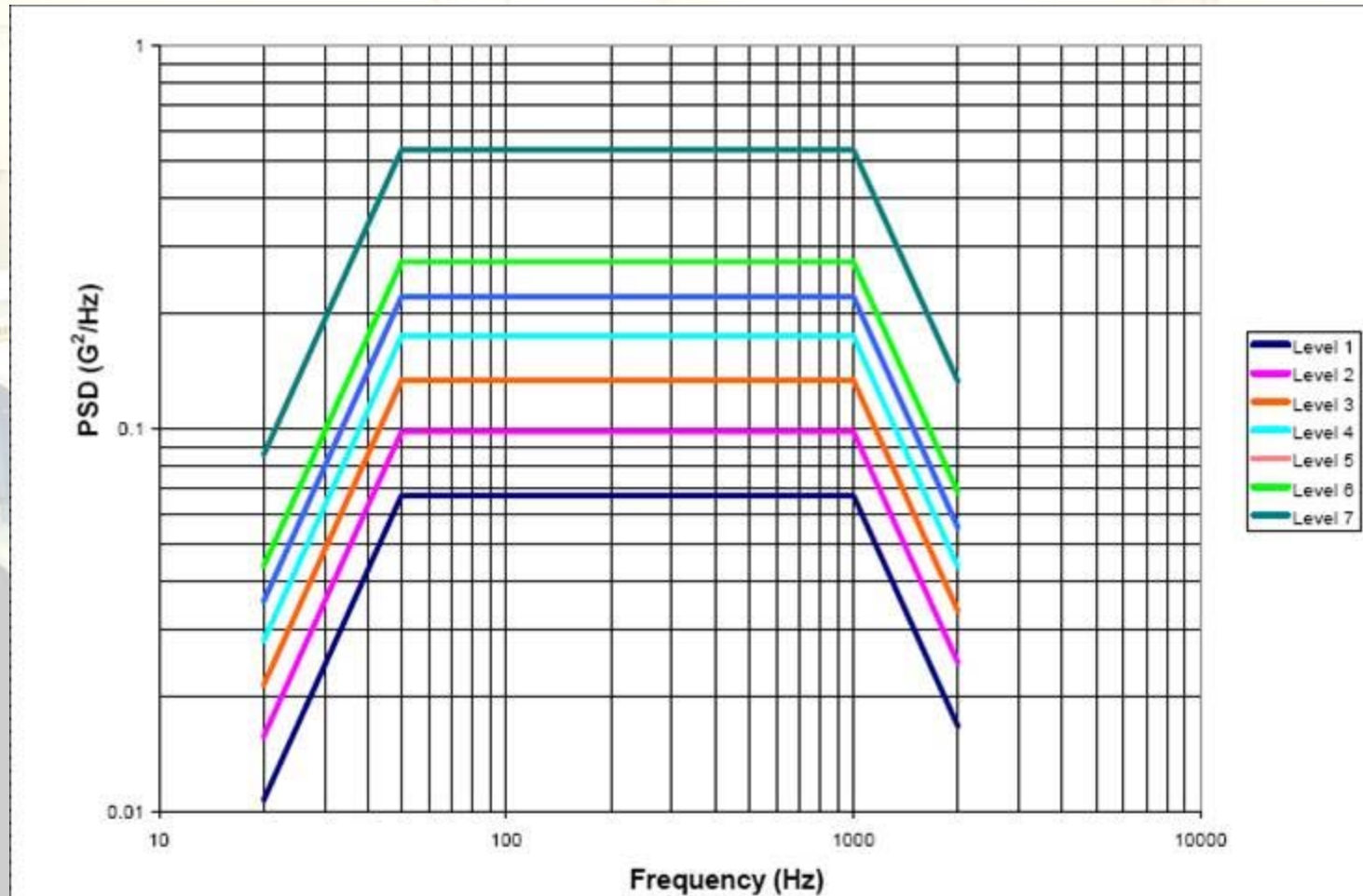




# Z-Axis Setup



# Vibration Test levels

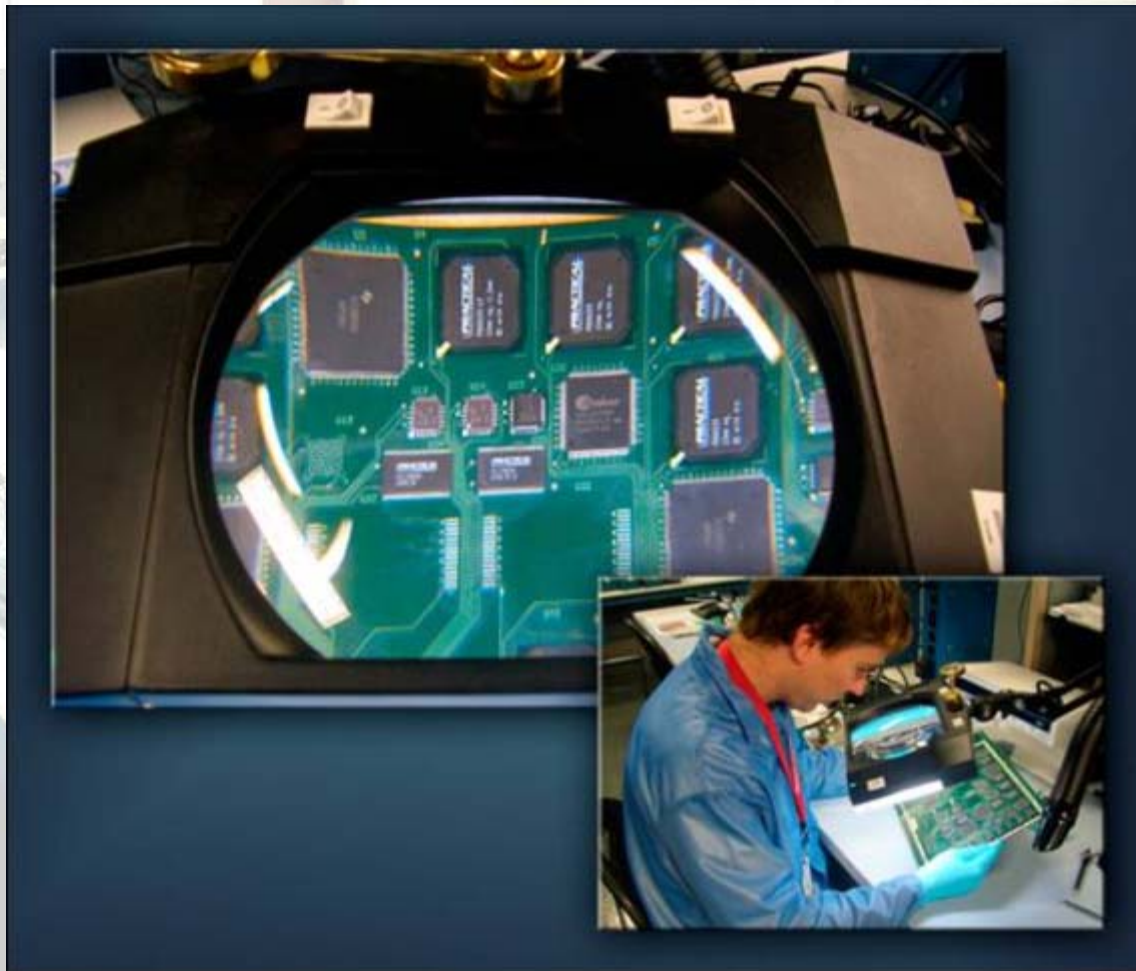


Woodrow, T., Modeling of the JCAA/JG-PP Lead-Free Solder Project Vibration Test Data

**Energetic Materials Research and Testing Center** METTOP



# Post Test Damage





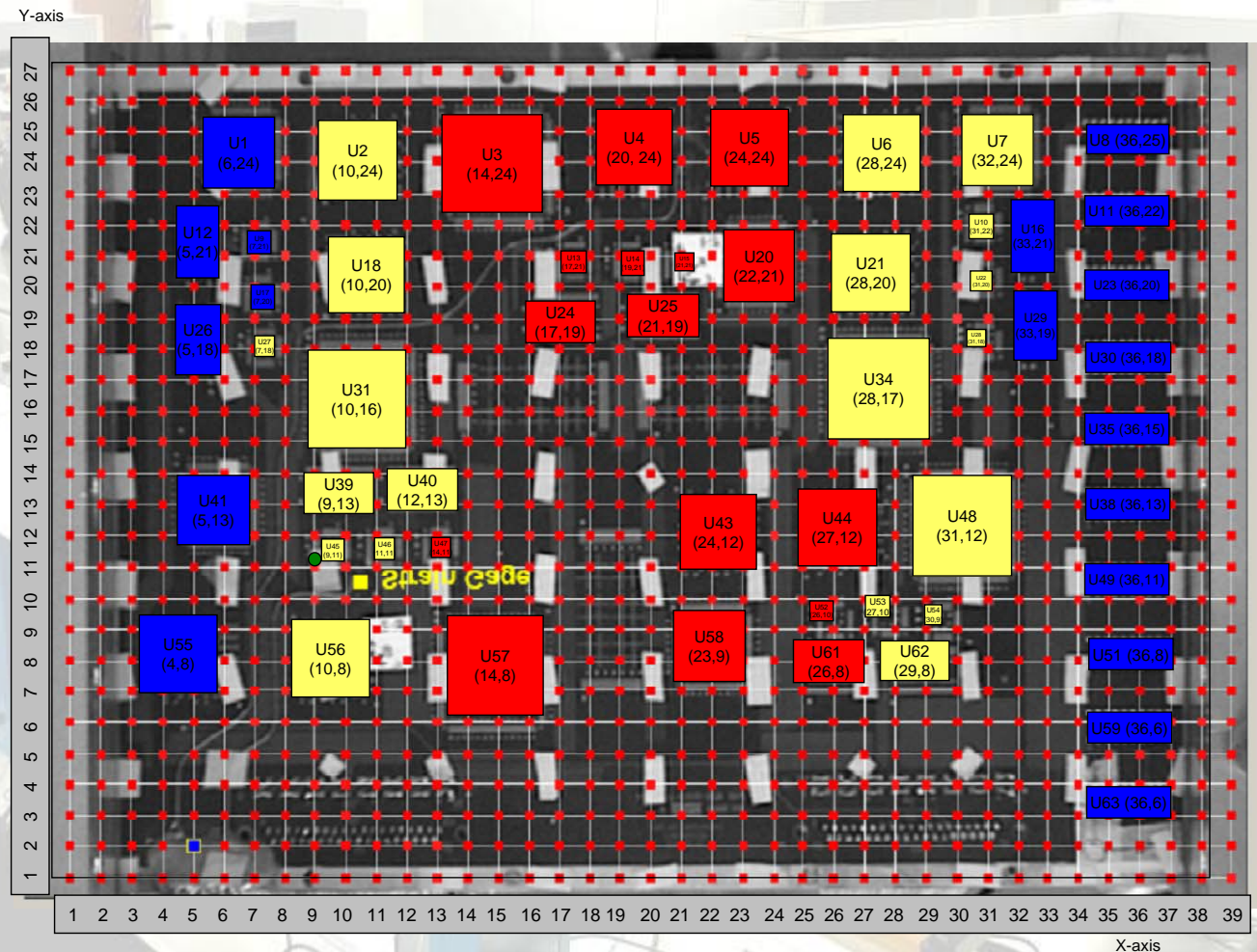
# Results

- Overall decrease in failures from original JGPP study, despite stiffeners not staying attached.

Axis	Test Level	%Failed (JCAA/JGPP)	%Failed (METTOP)	# of Stiffeners at end of level
Y-axis	9.9 Grms	0	0	9
X-axis	9.9 Grms	0	0	8
Z-axis	9.9 Grms	7.7	5.5	4
Z-axis	12.0 Grms	17.7	9.9	0
Z-axis	14.0 Grms	29.2	17.2	0
Z-axis	16.0 Grms	39.1	26.1	0
Z-axis	18.0 Grms	46.9	33.0	0
Z-axis	20.0 Grms	55.6	43.1	0
Z-axis	28.0 Grms	68.4	54.2	0

# Strain Region Analysis

- Russell, Fritz, Latta: assign strain regions to PCB board.
- Easier to compare components within strain regions.





# Comparison of Results

Zone	Solder	JGPP Study						
		TQFP-208	TQFP-144	PLCC-20	TSOP-50	PDIP-20	CLCC-20	BGA-225
Center	SAC							
	SACBi							
	SnPb							
Low	SAC							
	SACBi							
	SnPb							
Edge	SAC							
	SACBi							
	SnPb							
	SnCu							
Zone	Solder	NMT Study						
		TQFP-208	TQFP-144	PLCC-20	TSOP-50	PDIP-20	CLCC-20	BGA-225
Center	SAC							
	SACBi							
	SnPb							
Low	SAC							
	SACBi							
	SnPb							
Edge	SAC							
	SACBi							
	SnPb							
	SnCu							

# Overall Observations

- Markedly fewer failures than JGPP study
- SnPb performed best, followed by SACBi
- SAC consistently performed worst



# Accelerometer Data

- Accelerometers revealed three distinct resonances
- Accelerometer placement appeared to work well
- Further analysis being conducted

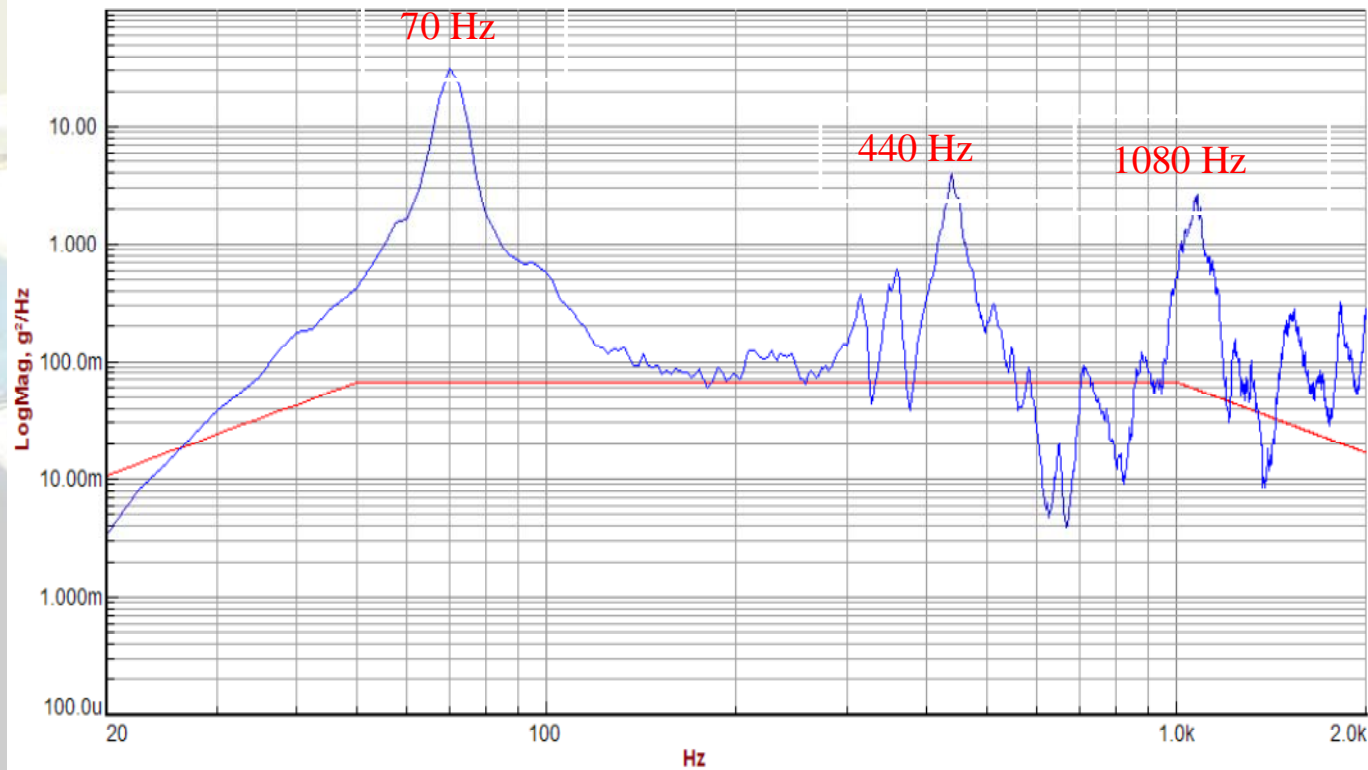
# Accelerometer Graph

Elapsed Time: 000:42:41  
Remaining Time: 0:00:00

EMRTC LEAD-FREE SOLDER  
LEVEL 1 VIBRATION, TEMP: AMBIENT  
AXIS: Z

Level: 0 dB

G18, 18; Ref



2/27/2008  
Test Start Time: 21:52:43

BOARD 106 B.C.  
Rms:27.46



# Questions?

## References

- Tom Woodrow, “JCAA/JG-PP Lead-Free Solder Project: Vibration Test,” Report EM/P-582, Rev A, January 9, 2006
- S. Pepe and L. Whiteman, “Environmental Exposure of JG-PP/JCAA Test PWAs”, January 31, 2005
- Bill Russell, Dennis Fritz and Gary S. Latta, “Methodology for Evaluating Data for “Reverse Compatibility” of Solder Joints”, SMTA International, October, 2007